REMARKS

In the last Office Action, the Examiner objected to the disclosure as containing informalities. Claims 1-7 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,120,140 to Hirosawa et al. ("Hirosawa"). Additional art was cited of interest.

In accordance with the present response, the specification has been suitably revised to correct informalities, including those noted by the Examiner, provide antecedent basis for the claim language, and bring it into better conformance with U.S. practice. Original claims 1-7 have been replaced by new claims 8-13 to further patentably distinguish from the prior art of record, improve the wording, and bring them into better conformance with U.S. practice. New claims 14-27 have been added to provide a fuller scope of coverage. A new abstract which more clearly reflects the invention to which the new claims are directed has been substituted for the original abstract.

Applicant respectfully requests reconsideration of his application in light of the following discussion.

Brief Summary of the Invention

The present invention is directed to an ink jet head and to an ink jet recording apparatus.

Fig. 11 discloses a conventional ink jet head. As described in the specification (pgs. 1-5), one significant problem with the conventional ink jet head is that ink cannot be efficiently discharged from nozzle apertures due to the generation of air bubbles in internal spaces of the ink jet head, including an ink reservoir, common ink chamber and grooves. The air bubbles remaining in the internal spaces of the ink jet head also cause vibrations during operation of the ink jet head. As a result, the conventional ink jet head has poor ink discharge characteristics which reduces the printing quality.

The present invention overcomes the drawbacks of the conventional art. Figs. 2-4B and 7 show one embodiment of an ink jet head 20 according to the present invention embodied in the claims. The ink jet head 20 comprise a substrate 31 having a grooves 33 for receiving ink and extending along a longitudinal direction. A nozzle plate 38 is connected to the substrate 31 and has nozzle apertures 32 each disposed in communication with respective ones of the grooves 31. An ink storing member (e.g., 60) stores ink to be supplied to the grooves 33. An ink chamber plate 36 is connected to the substrate 31 and has an ink chamber 37 for supplying ink from the ink storing member to the grooves 33.

According to the present invention, a flow path substrate 40 is connected between the ink storing member and the ink chamber plate 36 and contains at least portions of an ink flow path for transporting ink from the ink storing member to the ink chamber 37 of the ink chamber plate 36. The ink flow path has a tubular communicating passage 45, an ink reservoir 41B, an ink introduction passage 49B, and an ink supply passage 50B. The tubular communicating passage 45 has a first end connected to the ink storing member and a second end. The ink reservoir 41B contains a filter 44B which divides the ink reservoir 41B into an upstream space 47B disposed on a first side of the filter 44B and a downstream space 48B disposed on a second side of the filter 44B opposite the first side. The ink introduction passage 49B transports ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves 33 and has a first end connected to the second end of the tubular communicating passage 45 and a second end connected to the upstream space 47B. The ink supply passage 50B has a first end connected to the downstream space 48B and a second end connected to the ink chamber plate 36 for supplying ink to the ink chamber 37. The ink supply passage 50B is inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage 49B.

Preferably, each of the ink introduction passage 49B, the ink supply passage 50B, the upstream space 47B, and the downstream space 48B has a thickness smaller than an inner diameter of the tubular communicating passage 45.

In the embodiment shown in Fig. 7, the filter 44B is disposed generally parallel to the longitudinal direction of each of the grooves 33 and has an upper end disposed proximate the second end of the ink introduction passage 49B and a lower end disposed proximate the first end of the ink supply passage 50B. In another embodiment shown in Fig. 8, the filter (labeled 44C) is disposed generally perpendicular to the longitudinal direction of each of the grooves 33 and has lower and upper sides corresponding to the first and second sides of the filter, respectively.

By the foregoing constructions, the ink flow path of the ink jet head according to the present invention, as well as the location and orientation of the filter in the ink flow path, the generation of air bubbles within interior spaces of the ink jet head is minimized, thereby suppressing a reduction in the ink flow rate. As a result, degradation of the ink discharge characteristics, and thus degradation of the overall printing quality, of the ink jet head according to the present invention is prevented as compared to the conventional art.

Applicant respectfully submits that the prior art of record does not disclose or suggest the subject matter recited in newly added claims 8-27.

New independent claim 8 is directed to an ink jet head and requires a substrate having a plurality of grooves each for receiving ink and extending along a longitudinal direction, a nozzle plate connected to the substrate and having a plurality of nozzle apertures each disposed in communication with respective ones of the grooves, ink storing means for storing ink, an ink chamber plate connected to the substrate and having an ink chamber for supplying ink from the ink storing means to the grooves, means defining an ink flow path for transporting ink from the ink storing means to the ink chamber of the ink chamber plate, and a filter disposed in the ink flow path. Claim 8 further requires a flow path substrate connected between the ink storing means and the ink chamber plate and having at least portions of the ink flow path, the ink flow path having a tubular communicating passage having a first end connected to the ink storing means and a second end, an ink reservoir in which the filter is disposed to divide the ink reservoir into an upstream space disposed on a first side of the filter and a downstream space disposed on a second side of the filter opposite the first side, an ink introduction passage for transporting ink along a flow

direction generally perpendicular to the longitudinal direction of each of the grooves and having a first end connected to the second end of the tubular communicating passage and a second end connected to the upstream space, an ink supply passage having a first end connected to the downstream space and a second end connected to the ink chamber plate for supplying ink to the ink chamber, the ink supply passage being inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage, and each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space having a thickness smaller than an inner diameter of the tubular communicating passage.

The prior art of record does not disclose or suggest the structural and functional combination of the ink jet head recited in independent claim 8. For example, Hirosawa discloses an ink jet head having an ink flow passage or path 44 connecting an ink storing portion 41 to an ink ejecting portion 43 for ejecting the ink (Figs. 1-14(b)). A filter 46 is disposed in the ink flow path 44. As shown in Fig. 12, the ink flow path 44 has path portions 44a, 44b, 47b. The filter 46 is disposed in the path portion 47b which is inclined relative to the path portions 44a, 44b and relative to the ink ejecting portion 43.

However, Hirosawa does not disclose or suggest the specific flow passage recited in independent claim 8 which requires a tubular communicating passage, an ink introduction passage, and an ink supply passage which is inclined downwardly relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage. In contrast, as shown in Figs. 11-12 of Hirosawa, the path portion 44b corresponding to the ink supply passage (i.e., the passage connected to the ink ejecting portion 43), is not inclined as required by claim 8. Instead, the ink flow path in Hirosawa has the path portion 47b (corresponding to the ink reservoir) disposed at an inclination, rather than the ink supply passage, relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage (i.e., the path portion between 44a and 47b in Fig. 12 of Hirosawa).

Moreover, claim 8 requires that each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space has a thickness smaller than an inner diameter of the tubular communicating passage. In contrast, as shown in Fig. 11 of Hirosawa, the ink supply passage 44b, each of the upstream and downstream spaces in the ink reservoir 47b (formed by the filter 46), and the ink introduction passage (i.e., the path portion between 44a and

47b) has a thickness which is greater, not smaller than an inner diameter of the tubular communicating passage 44a.

Independent claim 14 is also directed to an ink jet head and requires an ink flow path having a communicating passage having a first end connected to the ink storing means and a second end, an ink reservoir in which a filter is disposed to divide the ink reservoir into an upstream space disposed on a first side of the filter and a downstream space disposed on a second side of the filter opposite the first side, an ink introduction passage for transporting ink along a flow direction generally perpendicular to the longitudinal direction of each of the grooves and having a first end connected to the second end of the communicating passage and a second end connected to the upstream space, and an ink supply passage having a first end connected to the downstream space and a second end connected to the ink chamber plate for supplying ink to the ink chamber, the ink supply passage being inclined downwardly toward the ink chamber of the ink chamber plate relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage. No corresponding structure is disclosed or suggested by the prior art of record as set forth above for independent claim 8.

New independent claim 22 is also directed to an ink jet head and requires means defining a plurality of parallel grooves each extending along a longitudinal direction for receiving ink stored in an ink storing member, an ink chamber disposed in communication with the grooves, and an ink flow path for transporting ink to the grooves via an ink chamber, the ink flow path having a communicating passage connected to the ink storing member, an ink introduction passage connected to the communicating passage for transporting ink along a flow direction generally perpendicular to a longitudinal direction of each of the grooves, an ink reservoir connected to the ink introduction passage, and an ink supply passage connected to the ink reservoir for supplying ink to the ink chamber, the ink supply passage being inclined downwardly toward the ink chamber relative to a horizontal line disposed generally parallel to the flow direction of ink in the ink introduction passage. Claim 22 further requires a filter disposed in the ink reservoir for filtering the ink supplied to the ink chamber. Again, no corresponding structure is disclosed or suggested by the prior art of record as set forth above for independent claim 8.

New claims 9-13, 15-21 and 23-27 depend on and contain all of the limitations of independent claims 8, 14 and 22, respectively, and, therefore, distinguish from the prior

art of record at least in the same manner as claims 8, 14 and 22.

Moreover, there are separate grounds for patentability of several of the new dependent claims.

New claims 9, 10, 19, 20, 26 and 27 are directed to the specific structural orientation of the filter with respect to the grooves. No corresponding structural features are disclosed or suggested by the prior art of record.

Claims 11, 17, 24 include the additional limitation that the thicknesses of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space are equal to one another. Claims 12, 18, 25 include the additional limitation that the thickness of each of the ink introduction passage, the ink supply passage, the upstream space, and the downstream space is equal to or less than 1.0 mm. No corresponding dimensional relationships are disclosed or suggested by the prior art of record. For example, as shown in Fig. 11 of Hirosawa, the thicknesses of the ink introduction passage (path portion between portions 44a and 47b), the ink supply passage 44b, and the upstream space and the downstream space (the ink reservoir 47b) are not equal to one another.

Claim 23 includes the additional limitation that each of the ink introduction passage, the ink supply passage,

the upstream space, and the downstream space has a thickness smaller than an inner diameter of the communicating passage. No corresponding dimensional relationship is disclosed or suggested by the prior art of record as set forth above for independent claim 8.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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